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공공정보시스템 구축사업의 원격개발 유형에 관한 연구

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요약: 본 연구는 기술적, 사회적 변화로 인해 촉발된 스마트워크를 공공정보시스템 개발사업에 적용하여 도입가능한 원격지 개발 유형을 조사하였다. 전문가 FGI를 이용하여 공공정보시스템 원격개발 유형을 도출하였고, 평가기준을 이용하여 개발자 및 발주기관으로 구분하여 9가지 유형 중에서 현실에 적합한 6가지 유형을 도출하여 평가하고, 공공정보시스템 개발 현장에 도입할 수 있는 4가지 옵션을 제안하였다. 공공정보시스템 구축사업에서 원격지 개발은 스마트워크와 같은 개별적인 원격근무를 의미하는 것이 아니라, 아웃소싱을 수행하는 개발자의 운영비 부담을 줄이고, 실질적인 문제를 해결하여 유능한 개발자를 확보할 수 있다. 이러한 원격 개발은 일과 삶의 균형을 위해 논의되고 있는 소프트웨어 개발자에게 스마트워크를 확대하는 논의로 발전할 것이다.

주제어: 스마트워크, 원격개발, 표적집단면접법, 공공정보시스템

A Study on the Types of Remote Development in Public Information System Development Projects

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Abstract: This study investigated the types of remote site development applied to public information system development projects by applying smart work triggered by technological and social changes. Using FGI, we derived the types of remote site development of public information system developers, and using evaluation criteria, we evaluated six realistic closures for developers and ordering organizations, and proposed four options that can be introduced in the field. In the public information system development project, remote site development does not imply individual remote work like smart work, but it is presented as a feasible plan in the category of broad smart work to reduce the burden of operating expenses for developers who perform outsourcing and to solve practical problems to enable the supply and demand of developers. We believe that such remote development will evolve into a discussion to expand smart work to software developers, which is being discussed for work-life balance.

Keywords: Smartwork, Remote development, FGI, Public information system

1. Introduction

Working from home due to COVID-19 has brought about a mindset shift from the previous workplace-oriented on-site work. People now recognize the benefits of working from home and accept it as a viable work types, even after COVID-19. This has been made possible by advances in networks, including mobile networks, and advances in technologies such as cloud computing.

Technological development and social change have a mutually influencing relationship. Depending on which of the two you focus on, it is divided into technological determinism and social constructionism. Social construction theory is a sociological theory that explains how social phenomena or consciousness develop in social context.

In the field of science and technology, the concept of social construction of technology is used. This is argued as a criticism of technological determinism, arguing that technology does not determine human behavior, but human behavior shapes technology, and that in order to understand technology, one must understand how technology is included in the social context in which it is placed. Technological determinism states that technological development is a driver of social change and leads social and economic changes. Since society evolves according to the characteristics of technology, it is possible to predict social change through technology because it has a set direction of evolution and affects society as a whole[1].

Smart work is a way to alleviate constraints on location and time, but it is influenced by technology and human factors. Smartwork is having a significant impact on the work patterns of office workers, and it is manifested in the demand for balancing between work and life, which has recently been labeled work-life balance. The term work-life balance first appeared in the United Kingdom in the late 1970s to describe the balance between an individual's work and personal life. Work-life balance is used to describe the balance an individual needs between the time allotted for work and other aspects of life, and is not limited to personal interests, family, social, and leisure activities. In recent year, with technological innovations such as networks and smartphones, work-life balance has also come to mean the separation of work and personal life so that one can get work done and have a personal life[2].

In other words, smart work refers to a system that allows you to work anytime, anywhere, without being tied to time and place, and means an expansion of the concept of working by overcoming the spatial constraints of tele-work or remote work. Such smart work refers not only to working from home or working at smart work centers scattered throughout the region, but also to mobile work[3-6].

In Korea, smart work also means that public

workers work in smart work centers. A smart work center is a workspace for remote work that provides an environment for users to work in an area close to their residence rather than their original workplace. It provides IT infrastructure like as, public computers with work S/W, secure computer networks, and work environment such as independent office desks, meeting rooms, necessary for work, as well as a video conferencing system for smooth communication with the original workplace[7-10].

One of the words that characterizes the transformation of our society is the digital age. The digital age is a society in which digital technologies are utilized throughout society. Software developers are the core group of workers to realize the digital society. Software development has been carried out in the form of a project, and a tight management system centered on a project manager is required to start the project, eliminate risks in the process, and produce development results until the end. In particular, in the case of outsourced projects, it is necessary to collect requirements from user groups and provide continuous feedback on the reflected results during the project period. In addition, public projects in Korea require confirmation of the participation of the outsourcing company's personnel in the project. These public projects are carried out in the form of a project team working together in a designated space due to environmental factors.

Looking at the institutional aspect, Article 32 of the Electronic Government Act states, "③ If necessary, the head of an administrative agency, etc. may have his or her employees work remotely online using an information and communications network without setting a specific work location." In addition, the Enforcement Decree of the Electronic Government Act recommends that central administrative agencies establish and implement measures to promote remote work, except for tasks that require on-site work. In addition, the National Civil Service Service Regulations of the Ministry of Personnel Management defines the remote work system as 'working using information and communications networks without specifying a specific work location' and divides it into tele-work type and smart work type, so that external work systems that carry out public informatization projects are classified into tele-work type and smart work type. It provides grounds that outsourcing companies can apply when conducting remote work.

In this study, we categorized remote site development, one of the remote work practices of developers participating in public development, and presented the results of feasibility evaluation using FGI for each type, so that it can be used as a reference for selecting remote site development methods for public institutions in the future.

2. Remote development of public information projects

As public institutions moved to regional areas, discussions on applying the remote work system to public informatization projects began in 2016. In other words, as a development company centered in the metropolitan area established a project office in a public institution that had relocated to a local area and supported employees' travel expenses, they complained of a sharp increase in operating expenses among project costs[11].

However, ordering organizations pointed out concerns about the lack of competence of SW developers and increased security management tasks for service projects as possible concerns in the case of remote development. SW companies pointed to the lack of project management capabilities of the client, unclear task requirements, and delays in decision-making. Both contracting agencies and SW companies cited "difficulty in communication" as a hindering factor, and problems that may occur when remote development is activated were also identified as issues to be resolved when introducing the system in published at Plan for

Activating Remote SW Development in Public SW Projects. In addition, institutionally, through the revision of the Software Promotion Act, Article 49(3) states that "The head of a state agency or the like shall allow a software company to propose a place of business when ordering a software project other than software maintenance and management. In this case, the head of a state agency may propose requirements for the place of business, such as matters related to information security," and Article 41 of the Ministry of the Interior and Safety's Guidelines for Building and Operating Information Systems for Administrative Organizations and Public Institutions states, "① The head of an administrative organization and the business operator shall mutually consult and determine the location, facilities, and other working environment necessary for the execution of the software business. However, the workplace of support personnel other than core development personnel may be determined by the other party to the contract, except in cases where there are special reasons such as security."

In a broad sense, the definition of remote work is defined as a work method based on IT that allows employees to perform part or all of their work at home or in geopolitically convenient locations rather than at a fixed workplace of their organization or company on a regular basis at least once a week. From the perspective of SW engineering, the types of remote sites are divided into needs analysis, basic design, and development depending on the project characteristics, customer situation, and security requirements, and the recent expansion of the cloud environment has eliminated constraints in terms of the environment for remote SW development.

In order to apply remote SW development to the field, workplace typification is desirable. This typology of SW development workshops can use various variables depending on the purpose of utilization, and ensures the convenience of comparative analysis by segmenting and categorizing

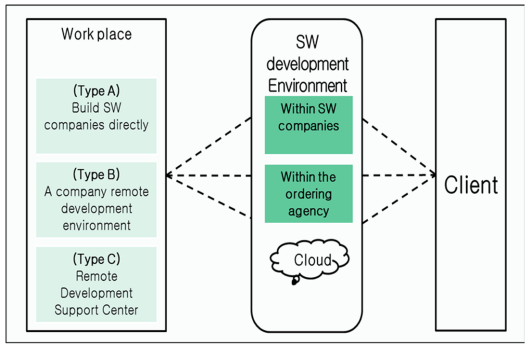

Figure 1. Remote Development Environment. (Source : Public SW Business Remote SW dEvelopment Activation Plan)

the objects to be analyzed. In order to create an advanced public SW business environment through the activation of remote SW development, the relevant ministries and agencies resolved a plan to activate remote SW development for public SW business and presented the structure of remote SW development.

3. Method

This study used expert FGI to derive remote development workplace types and analyzed the characteristics of each type using standard items for analysis by remote development workplace type. First, in order to classify development workplaces, the requirements presented in the 'Public SW Project Remote SW Development Activation Plan' are the government's policy direction when classifying workplace types. and was judged to be an appropriate standard item for uniformity, allowing typing of remote locations based on the workspace and SW development environment.

In order to classify developer workspaces, a conceptual definition of the derived types was conducted in advance. Afterwards, in order to first evaluate the logical structure of the types of work places and development environments, the Delphi technique was used for a committee of experts to collect first opinions online about 9 types considering all typification standard items,

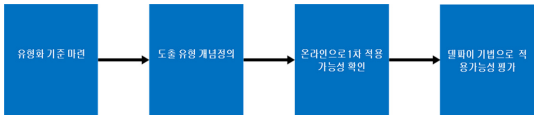

Figure 2. Workplace Type Classification and Evaluation Process.

Focus group interview consisting of 4 academic experts related to SW development such as engineering, management informatics, and industrial engineering, 4 private experts from a SW development company, and 3 experts from a company specializing in cloud service provision was conducted to classify the types of remote development sites.

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Second, one of the important differences that determines whether a software project becomes a successful software project or a project that becomes a failure or disaster is that it is essential to analyze the basic environment consumed during the development process, including costs, resources, and quality, at the beginning of the project. In other words, a project management area is necessary to successfully carry out a project, and Burke (1993) and Hormozi & Debue (1999) emphasize the need to manage time, cost, and quality and achieve goals in order to control all projects. Accordingly, in this study, in order to analyze risk factors by type of remote development, time, cost, and the factors of communication, business management, human management, and security,

Table 1. Evaluation Items for Type Comparison

Items	Contents
Cost	Cost of securing a location for development, network, development equipment, communication, etc.
Time	Included in the shortening of workers' commuting time, such as smart work centers implemented in the public sector in Korea.
Communication	Includes meetings for exchange and coordination of opinions between the ordering organization and the receiving developer, which are stakeholders in the project, meeting preparation time, meeting effectiveness, etc.
Project management efficiency	Due to the nature of the project, the efficiency of the project manager of the ordering company to frequently identify, control, and adjust the work progress status, issues, and situation of the developer (limited to cases of using a consortium joint work location)
Manpower supply	Possibility for the developer to supply and deploy manpower suitable for the project.
Security	Security elements that comply with the National Intelligence Service security guidelines and meet all requirements required by the client

which are the main qualities of remote SW workplaces, were established as analysis criteria and an analysis of the derived types was conducted. was carried out. Through literature analysis, the following six standard items were set for analysis by type of SW development workplace[12-14].

4. Results

4.1 Classification of remote development center types

In order to take detailed consideration of the workplace and SW development environment, it is necessary to elaborate on the type. Rennert defined workplace typology in 2007 as “typification is a theoretically and empirically derived concept that systematically organizes complex phenomena according to a limited number of attributes” [15].

Workplaces can be classified into realistic, ideological, experiential, structural, extreme, etc. according to the composition of the work environment, work content, and purpose of space utilization. In the case of typification of work places, they can be classified according to detailed criteria such as work characteristics, industry characteristics, surrounding environment, organizational culture, and organizational characteristics. The most representative type classification for work places is to categorize workplaces based on the flow of production methods. If you look at it, it can be divided into mass production method, Taylor Ford's lean production method, and autonomous team work method.

The core of remote location is the separation of locations, which in this project means a place separated from the ordering agency. Separation of a place far from the ordering agency means geographically outside the ordering agency, and among the outside of the ordering agency, it refers to a remote development area. The location that can be utilized is primarily the developer, and third locations other than the ordering agency and the developer may be utilized.

The third location is again divided according to the management entity of the building or place where the developer works. It can be divided into a development center managed by the private sector and a development center managed by the public, with the developer and ordering agency located on the X and Y axes. If each is divided into internal and external and schematized, they can be classified as follows.

The definitions for each classification type according to the developer's workplace can be divided into developer space utilization type, private remote SW development center utilization type, and public remote center utilization type.

When considering public SW development that deals with work data and personal information, the location of the development environment should be considered in addition to the classification by the location where the developer works. In some cases, the development environment is separated from the production environment and a development

Table 2. Classification of Space Utilization

Items	Contents
Developer space utilization type(A)	Development space within a developer that has received a project from an ordering agency
Private remote SW development center utilization type (B)	A development space managed by a private company that meets the requirements for a remote development work site.
Public remote center utilization type (C)	A development space managed by public institutions (government ministries, local governments, affiliated organizations, related associations, incorporated corporations, etc.) as a place that meets the requirements suitable for remote development work places.

server managed by the developer is used separately without operational data before unit testing, but for the sake of clarity and convenience, this study does not distinguish between the development and production environments and defines them as an integrated environment.

It is common for the development environment to be located in the ordering organization, but depending on the cloud computing technology and network environment, there may be cases where the location of the development environment is not the same as the workplace, and it is recommended that the information system be considered separately because it contains the most important data to be protected and is an important source of vulnerabilities that may occur in the development stage.

In remote SW development, similar to the classification according to the developer's workplace, there is a type of remote access to information resources located at the ordering agency in addition to the type located at the developer and the type located at a third place. In the case of the development environment located at the ordering agency and the developer, it is simple, but in the case of the third place, it may be located at a private or publicly managed development center as mentioned in the developer's workplace. In this case, it is preferable to classify the cloud as a public cloud rather than a private cloud or a government cloud, and the development environment can be collectively categorized as a cloud, including the ordering organization, the developer, and a third place. In this task, the meaning of cloud is defined as a broad cloud, and it refers to the method of entrusting

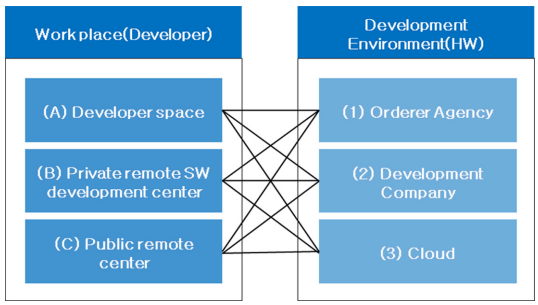

Figure 3. Remote SW Development Center Combination Type.

Table 3. Remote SW Development Workplace Type

Types	Contents
A-1	When a developer resides at a location installed by a business ordering company and utilizes the development environment installed by the ordering agency.
A-2	In case, where a developer resides at a location installed by a contracting company and the company directly installs and utilizes the development environment.
A-3	When a developer resides in a location installed by a contracting company and installs and utilizes a development environment in a third location (cloud)
B-1	When a developer resides in a SW development center established by a private professional company and utilizes the development environment installed by the ordering agency
B-2	When a developer resides in a SW development center established by a private professional company and the contracting company directly installs and utilizes the development environment.
B-3	When a developer resides in a SW development center established by a private professional company and installs and utilizes a development environment in a third location (cloud)
C-1	When a developer resides in a publicly installed SW development center and utilizes the development environment installed by the ordering agency
C-2	When a developer resides in a publicly installed SW development center and the business receiving company directly installs and utilizes the development environment.
C-3	When a developer resides in a publicly installed SW development center and installs and utilizes a development environment in a third location (cloud)

and operating computing resources to a third party other than the client and development entity.

The above workplace and development environment can be used as variables. In other words, unlike general remote work, SW development has the specificity of SW development environment, and as control over the development environment is emphasized, remote SW development centers can be classified into nine types as shown in the following figure 3 by the combination of developer workplace and development environment location.

4.2 Evaluation results by remote development center type

Because there is a difference in position on remote SW development between the developer and the ordering agency, the pros and cons of remote SW development were analyzed from the perspectives of the developer and the ordering agency based on the six types derived. In the case of ordering organizations, there are inconveniences in communication and difficulties in project management efficiency due to the separation of physical work locations, but remote SW development can contribute to improving ordering capabilities through separation between processes and detailed task requirements. Developers also face inconveniences in communication and difficulties in project management efficiency due to the separation of physical work locations, but through remote development, they have improved working conditions for SW developers and improved profitability by improving the budget and manpower input efficiency of SW projects. There is an advantage in securing corporate competitiveness through this. Accordingly, in this study, the remote SW development workplace types derived above were compared from the perspective of the developer and ordering organization, based on the existing development environment where SW developers reside and work within the ordering organization. The comparison of each item was divided into five levels (○ very negative ◔ negative ◑ average ◕ positive ● very positive), and the six standard items defined in this study were used to identify advantages and disadvantages.

The evaluation from the developer's perspective was based on the FGI results of four academic experts related to SW development, including SW engineering, management informatics, and industrial engineering, a private expert from a SW development company, and an expert from a cloud service provider company. In the case of remote development, it was confirmed that in all types, communication and project management efficiency had disadvantages compared to on-site development. On the other hand, remote development can be seen to have an advantage in that it can reduce related costs and time from the development company's perspective. Using a developer's own development environment can provide the most cost benefits, but using a cloud environment not only improves corporate agility by reducing initial investment costs and time, but also improves corporate agility through the scalability and elasticity of the cloud. It helps lay the foundation for innovation, including improved insight, by analyzing large data sets. Overall, the items with low measurement values were communication and project management efficiency, which were low as the physical distance between the developer and ordering agency increased, but due to the development of various applications for communication and project management-based technology, It is possible to overcome problems caused by physical distance through efficient process management using business management solutions. However, continuous efforts must be made to not only introduce technology and strengthen capabilities, but also to cooperate and communicate between ordering agencies and developers, and the public remote SW development center type was evaluated to have advantages in most items.

Comparative analysis of assurances by type from the ordering agency's perspective shows

that while cost and time items among the six evaluation items are significant factors for developers, ordering agencies manage the project based on the already confirmed project cost, so they are not subject to consideration. excluded. The evaluation from the ordering agency's perspective was conducted through a comparative evaluation conducted through a questionnaire targeting 7 experts from government agencies who have experience in ordering development projects. The average score of the seven experts' survey results was taken into consideration and converted into the same format as the results of the comparative analysis of pros and cons from the developer's perspective.

Comparing the pros and cons of each type, in the case of remote SW development, the ordering agency can see that it gains significant advantages in terms of manpower supply and demand during the project period, while communication and project management efficiency is evaluated to be significantly lowered. It has been done. In the case of communication and business management efficiency, the items with overall low measurement values were evaluated as necessary to overcome problems caused by physical distance through process management using various applications for communication and business management solutions. However, continuous efforts must be made to not only introduce technology and strengthen capabilities, but also to cooperate and communicate between ordering agencies and developers. In addition, the reason for the difference in the evaluation of communication and project management efficiency between the developer and the ordering agency appears to be the difference in the scope of communication and level of project management

Table 4. Developer perspective

Types	Items	Cost	Time	Communication	Project Mang.	Manpower supply	Security
	(On-site)	○	○	●	●	◔	●
Developer space	A-1	◑	◕	◔	◔	●	◕
	A-2	◕	◕	◔	◔	●	◑
	A-3	◕	◕	◔	◔	●	◕
Private remote development center	B-2	◑	◕	◔	◔	●	◕
	B-3	◑	◕	◔	◔	●	◕
Public remote center	C-1	◕	◕	◔	◑	●	◕
	C-3	●	◕	◔	◑	●	●

Table 5. Ordering Agency Perspective

Types	Items	Cost	Time	Communication	Project Mang.	Manpower supply	Security
	(On-site)			●	●	◔	●
Devel. space	A-1			◔	◔	◕	◔
	A-2			◔	◔	●	◔
	A-3			◔	◔	◕	◔
Private remote devel. center	B-2			◔	◔	●	◔
	B-3			◔	◔	●	◑
Public remote center	C-1			◔	◑	◕	◕
	C-3			◑	◔	◕	◕

Table 6. Recommendation type

Types Items (On-site)		Development Company	Ordering Agency	Results
Developer space	A-1	◑	◔	◔
	A-2	◑	◔	◔
	A-3	◕	◔	◑
Private remote development center	B-2	◑	◑	◑
	B-3	◕	◕	◕
Public remote center	C-1	◕	◕	◕
	C-3	◕	◕	◕

Table 7. Characteristic of Each Type

Place of work	Development environment	Contents
Developer space	Cloud (A-3)	Workplace management and operation utilizes the existing environment of the SW company, and the development environment and data are located in the cloud and managed by a professional company.
Private remote SW development center	Development Company (B-2)	The workplace is managed and operated by a professional operator, and the development environment and data are managed by the performing company.
	Cloud (B-3)	Workplace management and operation is performed by a professional operator, and the development environment and data are located in the cloud and managed by a professional company.
Public remote center	Orderer Agency (C-1)	Workplace management and operation are carried out at the remote development support center, and the development environment and data are managed by the ordering agency.
	Cloud (C-3)	Workplace management and operation are carried out at the remote development support center, and the development environment and data are managed in the cloud.

efficiency that each agency considers, and from the orderer's perspective, the public The remote SW development center type was evaluated as having advantages in most items.

In order to derive a type of recommendation suitable for applying remote SW development in the field, the evaluation from the existing developer side and the owner side were synthesized. The final type of remote SW development workshop was selected as A-3, B-2, B-3, C-1, and C-3, which were evaluated as having strengths in both developer and owner-side evaluations.

5. Conclusion

In this study, we used expert FGI to categorize the remote development of public information system developers, categorized them into developers and ordering agencies using evaluation criteria, and proposed possible measures. Such remote development does not mean individual remote work like smart work, but is in the broad category of smart work to reduce the burden of operating expenses on outsourcing development companies and solve realistic problems to enable the supply and demand of developers. It was presented as a feasible solution. It is believed that such remote development will develop into a discussion to expand smart work, which is being discussed for work-life balance, to software developers in the future.

In particular, in order for software developers to work remotely in public information projects to be realized, solutions to three issues of concern in the field must be prepared. The first is establishing

a communication channel between software developers in the project team. In other words, in a field work environment, it is possible to identify pending issues, divide work, and inspect performance results through offline meetings between project teams. However, in a remote work environment, communication between team members needs to be performed in a virtual environment, so establishing a platform for communication is required. Second, at the project task management level, it is necessary to be able to check work assignments and results for each team member. And finally, information security must be controlled during the project outcome or execution process in accordance with public security work regulations. Although the ultimate goal of information security is prevention or detection and control, there is a need to at least implement post-control.

At present, a blockchain-based DAO (DAO: Decentralized Autonomous Organization) can be considered to achieve the three above in a developer's remote work environment. It refers to an anonymous organization in which there is no manager and participants make decisions by voting according to the program, with a smart contract explaining in advance the automated decision-making structure or who and what economic transactions will be made based on the decision. In this way, blockchain-based DAO manages the division of work and the contribution of each participant through smart contracts, and records the project execution process as well as incentives according to the contribution, so although it is post-control, it is a way to secure information security.

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